CLAIMS:

1. An optical data storage system for recording and/or reading, using a radiation beam having a wavelength λ, focused onto a data storage layer of an optical data storage medium, said system comprising:

- the medium having m data storage layers where $m \geq 2$ and a cover layer that is transparent to the focused radiation beam, said cover layer having a thickness h_0 and a refractive index n_0, the data storage layers being separated by m-1 spacer layers having respective thicknesses h_j and refractive indices n_j, wherein $j = 1,\ldots, m-1$,
- an optical head, with an objective having a numerical aperture NA, said objective including a solid immersion lens that is adapted for recording/reading at a free working distance of smaller than λ/10 from an outermost surface of said medium and arranged on the cover layer side of said optical data storage medium, and from which solid immersion lens the focused radiation beam is coupled by evanescent wave coupling into the optical storage medium during recording/reading,

characterized in that,

any one of h_j is larger than

$$h_{j,\min} = \frac{b\lambda\sqrt{n_j^{\,2} - NA^2}}{NA^2}$$

and $NA < n_j$ and $NA < n_0$ and $b > 10$, preferably $b > 15$,

and the sum of all h_j is smaller than

$$h_{\max} = \frac{-\lambda \ln f}{8\pi nk}\sqrt{n^2 - NA^2}$$

where n and k respectively are the mean real and imaginary parts of the refractive indexes of all spacer layers, weighed with the thickness of each spacer layer:

$$n = \frac{\sum_j^{m-1} n_j h_j}{\sum_j^{m-1} h_j} \text{ and } k = \frac{\sum_j^{m-1} k_j h_j}{\sum_j^{m-1} h_j}$$

where k_j is the imaginary part of the refractive index n_j of the spacer layer and f is the demanded double pass transmission of the marginal ray of the focused radiation beam.

2. An optical data storage system as claimed in claim 1, wherein m = 2 corresponding to a medium with one spacer layer.

3. An optical data storage system as claimed in any one of claims 1 or 2, wherein the thickness variation Δh of any spacer layer over the whole medium fulfils the following criterium:

$$\Delta h < \frac{\lambda}{4n}$$

4. An optical data storage system as claimed in claim 3, wherein the thickness variation Δh of any spacer layer over the whole medium fulfils the following criterium:

$$\Delta h \leq \frac{\lambda}{8n(1+\cos\theta_m)} \text{ and } \cos\theta_m = \sqrt{1-(NA/n)^2}\,.$$

5. An optical data storage system as claimed in any one of claims 1, 2 , 3, or 4 wherein NA is larger than 1.5.

6. An optical data storage system as claimed in any one of claims 1 -5, wherein h_{max} is replaced by the following formula and the refractive index of the solid immersion lens n_{SIL} is n_s and the refractive index of any of the spacer layers is n_j:

$$h_{\max} = \frac{W_{RMS}}{\sqrt{\langle f_j^2\rangle - \langle f_j\rangle^2 - \frac{\left[\langle f_s f_j\rangle - \langle f_s\rangle\langle f_j\rangle\right]^2}{\langle f_s^2\rangle - \langle f_s\rangle^2}}}$$

in which the variables have the following meaning:

$$\langle f_s\rangle = \frac{2}{3NA^2}\left[n_s^{\,3} - \left(n_s^{\,2} - NA^2\right)^{3/2}\right],$$

$$\langle f_j\rangle = \frac{2}{3NA^2}\left[n_j^{\,3} - \left(n_j^{\,2} - NA^2\right)^{3/2}\right],$$

$$\langle f_s^{\,2}\rangle = n_s^{\,2} - \frac{1}{2}NA^2,$$

$$\langle f_j^{\,2}\rangle = n_j^{\,2} - \frac{1}{2}NA^2,$$

$$\langle f_s f_j \rangle = \frac{1}{4NA^2}\left\{\begin{bmatrix} n_s n_j^3 + n_j n_s^3 - \left(n_s^2 + n_j^2 - 2NA^2\right)\sqrt{n_s^2 - NA^2}\sqrt{n_j^2 - NA^2} \\ -\left(n_s^2 - n_j^2\right)^2 \log\left[\dfrac{\sqrt{n_s^2 - NA^2} - \sqrt{n_j^2 - NA^2}}{n_s - n_j}\right] \end{bmatrix}\right\}$$

and W_{RMS} is the maximum root mean square wavefront spherical aberration.

7. An optical data storage system as claimed in claim 6, wherein $W_{RMS} < 250$ mλ, preferably < 60 mλ, more preferably < 15 mλ.

8. An optical data storage medium for recording and reading using a focused radiation beam having a wavelength λ and a numerical aperture NA, comprising at least:

- m data storage layers where m ≥ 2, a cover layer that is transparent to the focused radiation beam, the cover layer having a thickness h_0 and a refractive index n_0, the data storage layers being separated by m-1 spacer layers having respective thicknesses h_j and refractive indices n_j, wherein j = 1,..., m-1,

characterized in that,

any one of $h_1, \ldots, h_{m-1}$ is larger than

$$h_{j,\min} = \frac{b\lambda\sqrt{n_j^2 - NA^2}}{NA^2}$$

and NA < n_j and NA < n_0 and b > 10, preferably b >15,

and the sum of all h_j is smaller than

$$h_{\max} = \frac{-\lambda \ln f}{8\pi nk}\sqrt{n^2 - NA^2}$$

where n and k respectively are the mean real and imaginary parts of the refractive indexes of all spacer layers, weighed with the thickness of each spacer layer

$$n = \frac{\sum_j^{m-1} n_j h_j}{\sum_j^{m-1} h_j} \text{ and } k = \frac{\sum_j^{m-1} k_j h_j}{\sum_j^{m-1} h_j}$$

where k_j is the imaginary part of the refractive index n_j of the spacer layer and f is the demanded double pass transmission of the marginal ray of the focused radiation beam..

9. An optical data storage medium as claimed in claim 8, wherein m =2 corresponding to a medium with one spacer layer.

10. An optical data storage medium as claimed in any one of claims 8 or 9, wherein the thickness variation Δh of any spacer layer over the whole medium fulfils the following criterium:

$$\Delta h < \frac{\lambda}{4n}$$

11. An optical data storage medium as claimed in claim 10, wherein the thickness variation Δh of any spacer layer over the whole medium fulfils the following criterium:

$$\Delta h \leq \frac{\lambda}{8n(1+\cos\theta_m)} \text{ and } \cos\theta_m = \sqrt{1-(NA/n)^2}\ .$$

12. An optical data storage medium as claimed in any one of claims 8, 9,10 or 11 wherein n is larger than 1.5.

13. An optical data storage medium as claimed in any one of claims 8- 12, wherein h_{max} is replaced by the following formula and the refractive index of the solid immersion lens n_{SIL} is n_s and the refractive index of any of the spacer layers is n_j:

$$h_{\max} = \frac{W_{RMS}}{\sqrt{\langle f_j^2\rangle - \langle f_j\rangle^2 - \frac{\left[\langle f_s f_j\rangle - \langle f_s\rangle\langle f_j\rangle\right]^2}{\langle f_s^2\rangle - \langle f_s\rangle^2}}}$$

in which the variables have the following meaning:

$$\langle f_s\rangle = \frac{2}{3NA^2}\left[n_s^3 - \left(n_s^2 - NA^2\right)^{3/2}\right],$$

$$\langle f_j\rangle = \frac{2}{3NA^2}\left[n_j^3 - \left(n_j^2 - NA^2\right)^{3/2}\right],$$

$$\langle f_s^2\rangle = n_s^2 - \frac{1}{2}NA^2,$$

$$\langle f_j^2 \rangle = n_j^2 - \frac{1}{2} NA^2,$$

$$\langle f_s f_j \rangle = \frac{1}{4NA^2} \left\{ \begin{bmatrix} n_s n_j^3 + n_j n_s^3 - \left(n_s^2 + n_j^2 - 2NA^2\right)\sqrt{n_s^2 - NA^2}\sqrt{n_j^2 - NA^2} \\ -\left(n_s^2 - n_j^2\right)^2 \log\left[\dfrac{\sqrt{n_s^2 - NA^2} - \sqrt{n_j^2 - NA^2}}{n_s - n_j}\right] \end{bmatrix} \right\}$$

and W_{RMS} is the maximum root mean square wavefront spherical aberration.

14. An optical data storage medium as claimed in claim 13, wherein $W_{RMS} < 250$ mλ, preferably < 60 mλ, more preferably < 15 mλ.

15. An optical data storage medium as claimed in any one of claims 8- 14, wherein the spacer layers comprise a polyimide substantially transparent to the radiation beam.

16. An optical data storage medium as claimed in claim 15, wherein the polyimide is UV curable.